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Optimization of Local Resources as Organic Fertilizer Through Various Formulations for Pakcoy Plant Growth

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Abstract: Organic fertilizers are the result of microbiological activity in breaking down organic matter. They are slow-release, and can remain in the soil longer than inorganic fertilizers. Applying organic fertilizers can increase soil microbial activity, suppress plant diseases, and improve nutrient absorption efficiency, thereby maintaining or increasing soil and plant productivity (Miner et al., 2020).

This research creates organic fertilizer/compost using various waste formulations from local resources, expected to produce quality organic fertilizer with macronutrient content in accordance with the standards of the Minister of Agriculture Regulation no. 261/KPTS/SR.310/M/4/2019.

The research aims to: 1) determine the best nutrient content of organic fertilizer from cow, goat and leather waste, 2) determine the quality of organic fertilizer from research results by comparing the standards of Permentan no. 261 / KPTS / SR.310 / M / 4/2019, and 3) measure the growth of pak choy plants.

The results of the study showed that : 1) the best nutrient content is organic fertilizer from cowshed waste with an organic C content of 31.17%, a C/N ratio of 17.42, a total N of 1.820%, a total P of 0.135, a total K of 0.256% and a pH of 7.78. 2) the organic fertilizer results of the study when compared with the standard of Permentan no. 261/KPTS/SR.310/M/4/2019 are still below the standard so they have low nutrient quality, and 3) the application of organic fertilizer does not significantly affect the growth of height, number of leaves, length and width of leaves of pak choy plants.

Keywords: *Organic Fertilizer; Waste; Local Resources; Pakcoy Plants.*

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I. INTRODUCTION

Farmers sometimes use inorganic fertilizers beyond established recommendations (Hartati et al., 2014). The resulting impacts include a decline in soil quality, including chemical, physical, and biological properties, which can reduce soil and plant productivity (Hartati et al., 2014). In addition to addressing plant nutritional needs, soil health needs to be conserved within the concept of sustainable agriculture. Healthy soil has ideal chemical, physical, and biological properties to support plant productivity and land sustainability (Fuentes et al., 2006).

Soil health is the soil's ability to function as a living ecosystem, supporting the sustainability of plants, animals, and humans, and preventing land degradation (Sutanto, 2002). Efforts to maintain soil health include restoring organic matter. This can include applying organic fertilizer, either in solid or liquid form.

Organic fertilizers are the result of microbiological activity in breaking down organic matter and have slow-release properties but can be available in the soil for longer than inorganic fertilizers (Darwis, 2014). The application of organic fertilizers also plays a role in increasing soil microbial activity and suppressing the presence of plant diseases (Jones and Benton, 2003). and increase the efficiency of nutrient absorption (Darwis, 2014) , so that it can maintain or increase soil and plant productivity.

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Hartatik et al. (2015) stated that excessive fertilization causes a decrease in soil fertility (decrease in N, P, and K values in the soil). In addition to these problems, excessive use of chemical fertilizers can cause agricultural soil to become harder and disrupt the balance of organisms that fertilize the soil (Puspadewi et al., 2016). Meanwhile, the use of compost as a source of soil and plant food is still hampered by problems such as the need for large quantities, low nutrient content, and slow mineralization processes (Hadisuwito, 2007) .

Increasing the productivity of vegetables, especially pak choy, can be done with proper cultivation management, one of which is fertilization. Fertilization can be done using organic fertilizers (Sihotang et al., 2013). Organic fertilizers have an important role in improving the physical, chemical, and biological properties of the soil. Although the nutrient content contained in organic fertilizers is relatively low, their role in the chemical properties of the soil far exceeds that of synthetic chemical fertilizers (Hartatik et al., 2015) . The role of organic fertilizers in the chemical properties of the soil is: (a) providing macronutrients (N, P, K, Ca, Mg, and S) and micronutrients (Zn, Cu, Mo, Co, B, Mn, and Fe), (b) increasing the cation exchange capacity (CEC) of the soil, and (c) can form complex compounds with toxic metal ions such as Al, Fe, and Mn so that these metals are not toxic.

The role of organic fertilizer on the physical properties of the soil includes: (a) improving soil structure because organic matter can absorb soil particles into stable aggregates, (b) improving the distribution of soil pore sizes so that the water holding capacity of the soil becomes better and air movement (aerase) in the soil also becomes better, and (c) reducing (buffering) soil temperature fluctuations. The role of organic fertilizer on the biological properties of the soil is as a source of energy and food for soil micro and meso fauna. With sufficient availability of organic matter, the activity of soil organisms increases which also increases nutrient availability, soil nutrient cycling, and the formation of soil micro and macro pores by macroorganisms such as earthworms, termites, and colembola (Solihin, et al., 2019).

Organic fertilizers/compost have a lower macronutrient content than synthetic fertilizers produced in factories. However, compost offers other advantages that chemical fertilizers lack: its role in improving the physical and microbiological structure of the soil, as well as various substances that can improve nutrient status (Mangkoedihardjo, 2006). Compost helps improve soil structure and increases porosity, making the soil looser and better able to retain water (Anonymous, 2021) .

Compost applied to land or plants must have entered a mature and stable phase. According to Budiyani et al. (2016) , unstable compost has a high BOD ratio, thus creating a favorable condition for microbial growth or high biological activity, so there is concern that the decomposition process will still occur which can interfere with the growth and absorption of nutrients by plants. To reduce the excessive use of chemical fertilizers, alternatives can be implemented such as combining chemical fertilizers with compost, better known as compost enrichment.

A. Problems

- Conventional farming has a negative impact on soil quality, thereby reducing fertilization efficiency and crop productivity.
- How to utilize local resource waste to reduce synthetic nutrients and prevent environmental pollution.
- Utilizing waste into products that have high sales value and benefits, namely organic fertilizer plays an important role in improving the physical, chemical and biological properties of the soil, even though the nutrients are relatively low, its role in soil properties far exceeds that of synthetic chemical fertilizers.

B. Special Purpose

- Knowing the best nutrient content of organic fertilizer from cow pen waste, goat pen waste and shrimp shells
- Knowing the quality of organic fertilizer from research results by comparing the standards of Permentan no. 261/KPTS/SR.310/M/4/2019
- Measuring the growth of pak choy plants.

C. Urgency of Research

- This research can provide insight into how to utilize waste from local resources to become a product that has economic value, namely organic fertilizer, and can improve soil fertility on marginal land so that it can support the growth and development of bok choy plants.
- Organic fertilizer is produced from agricultural waste using the fermentation method, producing organic fertilizer in solid form from organic materials from plant waste and animal waste which contain macro and micro nutrients and are easily absorbed by plants.
- The advantages of organic fertilizer are that it quickly overcomes nutrient deficiencies, has no problems with nutrient leaching, and is able to provide nutrients quickly, and functions as a fertilizer.

II. RESEARCH METHODOLOGY

A. Time and Place of Research

This research lasted for 4 months, from July to November 2025, covering the production of organic fertilizer, analysis of the nutrient content of organic fertilizer and application of bok choy plants to marginal land.

The research was conducted separately, namely in the soil science laboratory (chemical analysis of organic fertilizers), and on land as a place for planting pakcoy.

B. Tools and Materials

Equipment includes: buckets, ladles, measuring cups, boxes, blenders, machetes, knives, hoes, shovels, scales, arco chopping machines, and sieves , glass bottles, office stationery, and cameras.

Ingredients include: cow pen waste, goat pen waste, lemongrass, shrimp shells, water, rice washing water, granulated sugar, pakcoy seeds, manure, coconut fiber, husks, lamtoro gung, buckets , polybags, tarpaulins, label paper, and tissues.

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C. Research Procedures

Activity stage I

➢ *Organic Fertilizer Treatment*

There are 4 raw material treatments, namely:

K0 : control
K1 : cow shed waste + lemongrass + lamtoro gung + water + sugar + rice washing water
K2 : goat pen waste + lemongrass + lamtoro gung + water + sugar + rice washing water
K3 : lamtoro gung + shrimp shell + coconut fiber + rice husk + rice washing water + sugar + water

➢ *Making Solid Organic Fertilizer*

- Make a solution of 2.5 kg of granulated sugar for each treatment in 25 l of water, and 10 l of rice water.
- Comparison of raw materials used: 6 kg of goat/cow/shrimp shell waste, 2 kg of rice husk charcoal, 2 kg of coconut fiber, 2 kg of lamtoro gung leaves.
- How to make organic fertilizer

The coarse material from the liquid organic fertilizer production process is then filtered, and the solids are fermented again to become solid organic fertilizer (compost), which is then removed and used for composting. The compost material is placed on the floor and covered with a tarp, ensuring the pile is out of direct sunlight and rain.

D. Observation

During the composting process, physical observations of the compost are made daily, including changes in shape, color, and odor, comparing the initial compost to the finished compost. Compost is considered finished when it is blackish-brown, odorless, crumbly, and easily disintegrates.

Activity stage II

➢ *Analysis of Nutrient Content of Organic Fertilizer*

Conduct nutrient analysis of solid and liquid organic fertilizers, namely: Nitrogen, Phosphorus, Potassium, organic C, pH, and C/N ratio. Then, the data is presented in tabular form.

- *Analysis of Marginal Soil Nutrient Content*

The soil to be used in the research was first analyzed to determine the nutrient content of the soil, including: pH, C/N ratio, organic C, N, P, and K.

- *Measuring the Quality of Organic Fertilizer*

The results of the analysis of the nutrient content of organic fertilizer from three formulation treatments were then compared with the standard of Permentan no. 261/KPTS/KPTS/SR.310/M/4/2019 to determine the quality of organic fertilizer.

Research phase III

In this third stage, planting or direct application of organic fertilizer is carried out to the marginal soil planting medium by planting pakcoy plants as test plants.

The steps:

➢ *Preparation of Research Planting Media*

The research demonstration plot was made with dimensions of 10 m x 5 m = 50 m^2 which was given organic fertilizer treatment according to the treatment.

➢ *Preparation of Treatment*

Prepare organic fertilizer treatment according to the treatment, namely: K0, K1, K2, and K3, then apply it to the pakcoy plants.

➢ *Land Management*

The research used soil that had been previously treated and left for 1 week so that the treatment had mixed with the soil.

➢ *Observation*

The parameters observed in this study were the growth of pak choy plants such as: plant height, number of leaves, length and width of leaves, which were carried out once a week with an observation period of 4 weeks after transplanting.

➢ *Data Analysis*

The data obtained were analyzed using a Completely Randomized Design with correlation using the SPSS program with the F Test and further tests at the 5% level. This study consisted of 4 treatments and 10 replications.

III. RESULTS AND DISCUSSION

A. Making Organic Fertilizer

During the composting process, physical observations of the compost are made daily, including changes in temperature, shape, color, odor, and moisture, comparing the initial compost to the finished compost. Compost is considered finished when it is blackish brown, odorless, crumbly, and easily disintegrates, and the temperature has stabilized near room temperature .

Table 1. Observations of the Physical Properties of Solid Organic Fertilizer

Treatment	Initial Observation			End of Observation		
	Color	Smell	Form	Color	Smell	Form
Goat pen waste	Black	Smell of the material	A bit broken	Black	The smell of earth	Destroyed
Cow shed waste	Dark brown	Smell of the material	A bit broken	Brownish black	The smell of earth	Destroyed
Shrimp shell waste	Brownish	Smell of the material	A bit broken	Dark brown	Smell of the material	Destroyed into fibers

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Based on observations in Table 1, it can be seen that the fermentation process in making solid organic fertilizer with a fermentation period of 21 days shows that the physical changes in the solid organic fertilizer, which was initially dark to slightly light in color, changed to dark after going through the fermentation process to become solid organic fertilizer (compost).

Mature compost is black, brownish-black, or blackish brown. The color change at the end of the composting process is caused by the decomposition of organic matter by various microorganisms. Aerobic decomposition is indicated by a color change to black (Yuriansyah et al., 2020).

The color change is caused by the loss of nitrogen resulting from the decomposition process that occurs in composting. The heat generated is able to break down lignin bonds so that nitrogen is reduced so that the color changes to brown and composting enters the maturation phase. During the composting process, organic material will decompose by microbial activity, namely microbes will take water, oxygen and nutrients from organic material which will then decompose and release CO_2 and O_2 (Baroroh, 2015). In addition, the color change in the physical compost according to Sunarsih (2018) that the change in material from light to dark is influenced by the main ingredients used, the color produced by each material can be used as an indicator of the success of making the organic fertilizer.

In the process of making solid organic fertilizer (compost) the results of the study at the beginning of the manufacture did not smell but at the end of the observation there were some that had a pungent smell, this was because the materials used in making compost were waste from cow pens, goat pens and shrimp shells where all three materials have a rather pungent smell. According to Hadi, (2019), the weakness of compost from waste from goat pens, cow pens and shrimp shells is that it will produce a fairly pungent stench and can make the head feel dizzy, the smell caused in making compost can actually be overcome by using decomposers and providing aeration, because if aeration is hampered, an anaerobic process occurs which produces an unpleasant odor. The anaerobic process will produce compounds that smell unpleasant such as organic acids, ammonia and H_2S (Nurman, et al., 2019). Aeration can be increased by turning the compost pile.

Mature compost is crumbly, feels soft when crushed, and crumbles easily when squeezed. The volume/weight of the compost decreases as it matures. In this study, the volume of the compost decreased by 20%. According to (Ngapiyatun, et al., 2022) that organic materials in compost making undergo various biological changes carried out by microorganisms, these changes are: (1) decomposition of carbohydrate, cellulose, hemicellulose and others into CO_2 and water, (2) decomposition of fat and wax into CO_2 and water, (3) decomposition of egg white through amides and amino acids into ammonia, CO_2 and water, (4) binding of several types of nutrients in the bodies of microorganisms, especially N, P and K, these elements will be released again when the organisms die, and (5) release of nutrients from organic compounds into inorganic compounds that are useful for plants.

B. Analysis of Nutrient Content of Organic Fertilizer

Once finished, organic fertilizer is then analyzed in a laboratory to determine its nutrient content. This information can be seen in the following table.

Table 2. Nutrient Content of Organic Fertilizer Pad at

Observed Elements	**Mark**		
	Goat Manure	**Cow dung**	**Shrimp Shell**
C-Organic (%)	10.10	31.17	23.69
C/N ratio	21.26	17.42	27.32
N Total (%)	0.475	1,820	0.867
P Total (%)	0.143	0.135	0.054
Total K (%)	0.616	0.256	0.053
pH	9.48	7.78	6.65

Based on Table 2, it can be seen that the best nutrient content among the three treatments is POC from cow dung waste compared to other waste treatments, namely with a C-Organic value of 31.17%, total N 1.820%, total P 0.135%, total K 0.256%, C/N ratio 17.42 and pH 7.78. According to Marsono and Sigit (2002) , this is because cow dung waste contains more organic matter overall, is very effective in improving the physical structure of the soil, making it looser and more fertile, and is a good source of energy for soil microorganisms, increases fertility, provides essential nutrients such as nitrogen, phosphorus, and potassium.

Table 3. Nutrient Content of Solid Organic Fertilizer from Cow Pen Waste

Observed Elements	**Mark**	**Standard of Minister of Agriculture Regulation 261/KPTS/SR.310/M/4/2019**	**Information**
C-Organic (%)	31.17	Min 15	In accordance
C/N ratio-	17.42	≤ 25	In accordance
N Total (%)	1,820	Min 2	It is not in accordance with
P Total %	0.135	Min 2	It is not in accordance with
K Total (%)	0.256	Min 2	It is not in accordance with
pH H2O	7.78	4-9	In accordance

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Table 4. Nutrient Content of Solid Organic Fertilizer from Goat Pen Waste

Observed Elements	Mark	Standard of Minister of Agriculture Regulation 261/KPTS/SR.310/M/4/2019	Information
C-Organic (%)	10.10	Min 15	It is not in accordance with
C/N ratio -	21.26	≤ 25	In accordance
N Total (%)	0.475	Min 2	It is not in accordance with
P Total (%)	0.143	Min 2	It is not in accordance with
K Total (%)	0.616	Min 2	It is not in accordance with
pH	9.48	4-9	It is not in accordance with

Table 5. Nutrient Content of Solid Organic Shrimp Shell Fertilizer

Observed Elements	Mark	Standard of Minister of Agriculture Regulation 261/KPTS/SR.310/ M/4/2019	Information
C-Organic (%)	23.69	Min 15	In accordance
C/N ratio	27.32	≤ 25	It is not in accordance with
N Total (%)	0.867	Min 2	It is not in accordance with
P Total (%)	0.054	Min 2	It is not in accordance with
K Total (%)	0.053	Min 2	It is not in accordance with
pH H2O	6.65	4-9	In accordance

Based on Tables 3, 4, and 5, it can be seen that the nutrient content of solid organic fertilizer from cowshed waste, goatshed waste, and shrimp shells when compared to the standards of Permentan no. 261 / KPTS / KPTS / SR.310 / M / 4/2019 are all still below the standard, and only the pH that meets the standard is between 4-9, namely from cowshed waste pH 7.78 and from shrimp shells pH 6.65. While for the appropriate C / N ratio is from cowshed waste and goat cage waste, which is below the standard ≤ 25. The appropriate C-Organic content is solid organic fertilizer from cowshed waste and shrimp shells. While for other nutrients such as N, P, K total has not met the standard, so the quality of the solid organic fertilizer is still low so that it is necessary to add other materials to increase the nutrient content of the fertilizer to meet the standard.

The nutrient content of organic fertilizers, both solid and liquid, for all treatments was low and did not meet the Standard of Permentan 261/KPTS/SR.310/M/4/2019 for C-organic, N, P, and K content. This was because the basic ingredients used were single and unvaried materials, which caused the low nutrient content. In addition, it was also influenced by the time of the composting process which was not optimal and without the addition of activators that could accelerate the composting process. Mature compost is generally dark in color (blackish brown) and its texture is crumbly and its original shape is no longer visible. The addition of mature compost will contribute N to the soil and plants will get additional N elements from the compost (Arifin, et al., 2020).

The total nitrogen content obtained from the organic fertilizer samples from the research did not meet the standards of the Ministry of Agriculture. This is thought to be caused by the compost raw materials, the fineness of the media during shredding, and the inversion of the compost that was not optimal, thus significantly affecting the nitrogen content of the compost. In addition, the lignin content in the compost material was not balanced with the availability of nitrogen content where the relationship between C and N lost in the composting process showed that 85% of the total initial N of the compost was available for microbes to grow so that the use of *M. bracteata bacteria* containing high nitrogen in composting will affect the availability of nitrogen which is an important factor in composting (Arifin, et al., 2020).

The low organic C content for all treatments is due to the concentration and amount of materials that do not vary in each treatment, thus affecting the fermentation process on the quality of the fertilizer, which does not run well because the fermentation process will run well if the organic C content is available sufficiently to help the growth of microorganisms in organic fertilizer. According to Budiyani, et al., (2016) that the low organic C content in organic fertilizer is caused by the organic C content having been broken down into simpler compounds by microorganisms contained in the organic fertilizer solution. Organic compounds will decrease while inorganic compounds will increase.

The results of the study showed that the low N content was caused by the fermentation process being carried out anaerobically, which caused the nitrification process to not run optimally, on the contrary the denitrification process was more dominant, besides it was also influenced by raw materials that were not varied. According to Budiyani, et al., (2016), the N content was influenced by the main ingredients of organic fertilizer, the concentration of the organic fertilizer manufacturing process affected the N content and the

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fermentation process did not run well. Several factors that influenced the decomposition results were the properties of the original material itself, the type of microorganisms that grew during fermentation, fermentation conditions and the length of fermentation time (Winarno in Budiyani, et al., 2016). Nitrogen sources greatly influenced the fermentation pattern, microorganisms would be able to grow rapidly in the presence of nitrogen elements and some required absolute nitrogen elements.

The low P content in both solid and liquid organic fertilizers indicates that concentration and fermentation time influence P availability in organic fertilizers. P content is influenced by pH. According to Budiyani et al. (2016), the higher the pH, the greater the available P content.

The low K content in organic fertilizer for all treatments is caused by the occurrence of sediment in organic fertilizers, both solid and liquid, so that the K element is not detected perfectly. In addition, the concentration of the raw materials used is only single without any additional materials that make the K content low. In addition, it is also influenced by the speed of microorganisms in fermenting. According to Kurniawan, et al., (2017), the low K content in liquid fertilizer is caused by differences in the speed of microorganisms in decomposing organic materials during fermentation. Differences in K content in each treatment are caused by differences in raw material concentration. The K content for all treatments is low and does not meet the standards of Permentan 261 / KPTS / SR.310 / M / 4/2019.
One of the criteria for the maturity of solid organic fertilizer or compost is the C/N ratio. The compost from research using cow and goat manure waste has a C/N ratio that meets the standards of the Ministry of Agriculture. However, the raw material of shrimp shells has not met the standards. This is because the raw material of the compost, namely shrimp shell waste, is rather difficult to decompose, so it requires a long process to be completely decomposed. The high C/N ratio in the compost from this research indicates that the compost from this research is not ready to be applied to plants as fertilizer because the compost in the soil will decompose further so that it can be absorbed by plant roots and used for plant growth (Nurman, et al., 2019), so that the compost can be used directly by plants for growth. During the composting process, organic material decays, $CO2_{is}$ released a lot, while N is not, so the C/N ratio decreases. This process continues until humus is formed. The process of decomposing organic material to form humus is called humification. The decrease in the C/N ratio in this compost is caused by a decrease in the amount of carbon used as an energy source for microbes to decompose or decompose organic material. The C/N ratio contained in the compost describes the level of maturity of the compost, the higher the C/N ratio means the compost has not decomposed perfectly or is not yet mature (Mulati, et al., 2020).

C. Pakcoy Plant Growth

➢ *Plant Height*

The results of the statistical test calculations of the response of organic fertilizer to the average increase in the height of pak choy plants at the age of 1, 2, 3 and 4 weeks after transplanting showed no significant difference as shown in Table 6 below.

Table 6. Height of Bok Choy Plants After Application of Organic Fertilizer (cm)

Treatment	Average Plant Height (cm)			
	1 MST	***2 MST***	***3 MST***	***4 MST***
K0	4.31 Mr.	2.35 tn	4.75 tn	5.75 tn
K1	4.28 Mr.	2.35 tn	6 tn	6.25 tn
K2	4.57 Mr.	3.55 tn	5.9 tn	5.95 tn
K3	4.53 Mr.	3.25 tn	5.11 tn	6.03 tn

Information:
tn: Not significant or not really different
MST : Weeks After Planting
K0=control, K1=shrimp shell, K2=cow pen waste, and K3=goat pen waste.

The application of organic fertilizer did not significantly increase plant height. This is because the bok choy plants are still adapting to their environment and is influenced by other factors, such as genetics. According to Lingga (2003), plant height is influenced by genetic factors and the environmental conditions in which the plants grow.

The application of organic fertilizer, whether solid or liquid, does not affect plant height because the absorption of nutrients by the plant increases while the supply of nutrients to support vegetative growth decreases. According to Mulyani Sutejo (2002), as the age of the plant increases, the provision of nutrients for growth and development becomes increasingly necessary.

The application of organic fertilizers, which contain low levels of N, P, and K, is insufficient and unbalanced for pak choy plants, thus preventing plant growth. According to Syafruddin et al. (2012), plants require N, P, and K, which are essential nutrients, to grow well. These nutrients play a significant role in plant growth in general during the vegetative phase.

➢ *Number of Leaves*

Based on the results of observations of the application of organic fertilizer according to treatment to marginal land, this can be seen in the following table.

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Table 7. Number of Leaves of Bok Choy Plants after Application of Organic Fertilizer (cm)

Treatment	Average Plant Height (cm)			
	1 MST	***2 MST***	***3 MST***	***4 MST***
K0	2 tn	3.7 tn	3.7 tn	2.9 tn
K1	2 tn	4.7 tn	4 tn	3.6 tn
K2	2 tn	4.5 tn	4.2 tn	3.1 tn
K3	2 tn	4.2 tn	4 tn	3 tn

Based on the results of statistical tests, it can be seen that the increase in the number of leaves of pakcoy plants (Table 7) at the age of 1, 2, 3, and 4 weeks after transplanting showed no significant effect or was not significantly different in all treatments. This is because the planting medium used was marginal soil that is poor in nutrients and the addition of organic fertilizer treatment that has not been fully decomposed and can be absorbed by plant roots. Which is known that the absorption of organic fertilizer is slow and requires time to be able to directly see the results on the application plants because it is still undergoing a further decomposition process and cannot be absorbed by the roots optimally and the N nutrient contained in the compost is relatively small/little so it is not able to meet the needs of vegetative plant growth, especially the number of leaves, plant height, length and width of leaves so that it gives an insignificant effect.

As stated by Dwidjoseputro (1998), plants will thrive and produce good yields if the nutrients they need are available in sufficient and balanced quantities. Furthermore, the relatively low nutrient content of soil conditioners results in a relatively low nutrient supply, resulting in suboptimal growth and development of oil palm plants (Liah et al., 2024). In line with the opinion of Karim et al. (2019), organic fertilizers are not only able to improve the physical, chemical, and biological properties of the soil but also add macro and micro nutrients to the soil, albeit in small amounts.

➢ *Leaf Length Increase*

Based on the results of observations of the application of organic fertilizer according to treatment to marginal land, this can be seen in the following table.

Table 8. Leaf Length of Bok Choy Plants After Application of Organic Fertilizer (cm)

Treatment	Average Plant Height (cm)			
	1 MST	***2 MST***	***3 MST***	***4 MST***
K0	0.6 tn	1.85 tn	0.82 tn	1.07 tn
K1	0.64 tn	2.61 tn	1.25 tn	1.4 tn
K2	0.53 tn	2.5 tons	0.96 tn	1.09 tn
K3	0.68 tn	2.82 tn	1.05 tn	1.27 tn

Based on the results of statistical tests, it can be seen that the increase in leaf length of bok choy plants (Table 8) at the ages of 1, 2, 3, and 4 weeks after transplanting showed no significant effect or was not significantly different in all treatments. At the age of 1 and 2 weeks after transplanting, there was no significant effect. This is because the bok choy plants are still young and still in the early growth stage. In addition, it is also caused by the plant's nutrient needs being met by the growing medium where they grow and are still adapting to the environment around their growth. The nutrients contained in the organic fertilizer provided are still in the process of being absorbed by the plant's organs. This is in accordance with the opinion of (Xu et al. 2010) that older seedlings reflect that the ability to adapt to the environment is faster, the faster the plant adapts, the faster the productivity because it is related to the plant's ability to adapt to the environment. When fertilizer is given, plants only utilize nutrients according to their needs because the plants are still relatively small so that the nutrient needs absorbed are only small.

The application of organic fertilizer did not show a significant effect on the average leaf length of pak choy plants at the age of 3 and 4 weeks after planting, this is because the nutrients provided do not meet the needs of the plants, so that some plants experience a deficiency or excess of nutrients. According to Isdarmanto (2009), with increased metabolic productivity, plants will require more nutrients and increase water absorption, this is related to the needs of plants during the growth and development period. The rate of plant growth tends to increase, if the nutrients needed by plants are sufficiently available and can be immediately utilized by plants, such as nitrogen, while based on the results of the analysis of the nutrient content of organic fertilizers from the study have low N, P and K elements. This is in line with the opinion of Harlina (2003) who stated that if the N element is available in large quantities, more protein is formed so that plant growth can be better.

There was no significant difference between these treatments because the vegetative growth of bok choy was rather slow because the organic fertilizer treatment contained complete nutrients but in small amounts, and the absorption process by plant roots was slower due to further decomposition, so it was not able to stimulate the growth of bok choy leaf length. The lack of significant difference between these treatments is suspected because the dose of organic fertilizer was not able to provide optimal nutrients for plant growth. This is in accordance with the statement of Hawayanti et al. (2020) who stated that if nutrients are less than optimal requirements, plant growth will also be suboptimal. This is in accordance with the opinion of Jurhana et al. (2017) who stated that if nutrient requirements are met, plant growth will increase.

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According to Roli (2013), compost fertilizer contains complete nutrients, both macro and micro nutrients, but the portion is small, such as N, P, K and other nutrients, so it is not sufficient to help the growth of pakcoy plants, such as leaf length. Potassium nutrients can also increase carbohydrate synthesis and translocation.

➢ *Leaf Width*

Based on the results of observations of the application of organic fertilizer according to treatment to marginal land, this can be seen in the following table.

Table 9. Leaf Width of Bok Choy Plants after Application of Organic Fertilizer (cm)

Treatment	Average Plant Height (cm)			
	1 MST	***2 MST***	***3 MST***	***4 MST***
K0	1.86 ^{tn}	1.11 ^{tn}	0.99 ^{tn}	1.13 ^{tn}
K1	0.84 ^{tn}	1.75 ^{tn}	1.22 ^{tn}	1.32 ^{tn}
K2	0.85 ^{tn}	1.51 ^{tn}	1.14 ^{tn}	1.19 ^{tn}
K3	0.78 ^{tn}	1.63 ^{tn}	1.18 ^{tn}	1.38 ^{tn}

Based on the results of statistical tests, it can be seen that the increase in leaf width of pak choy plants (Table 9) at the age of 1, 2, 3 and 4 weeks after transplanting showed no significant effect or was not significantly different in all treatments.

The lack of significant differences between treatments was due to the relatively slow vegetative growth of bok choy. This was due to the plant's inadequate absorption of organic fertilizer, which affected the growth of its leaves. This slow nutrient uptake was due to the fertilizer's high C/N ratio, which did not meet standards. Therefore, the organic fertilizer required further decomposition in the soil until the C/N ratio was reached and the nutrients could be absorbed by the plant roots.

According to Nurman, et al., (2019), the high C/N ratio content in the compost from this study indicates that the compost from this study is not ready to be applied to plants as fertilizer because the compost in the soil will decompose further so that it can be absorbed by plant roots and used for plant growth.

The leaf width growth of bok choy plants is rather slow because they are planted on marginal soil with low nutrient content. Therefore, the application of organic fertilizers, both solid and liquid, is rather slow to be absorbed by the plant roots, thus affecting the plant's growth process. This is because organic materials (solid and liquid organic fertilizers) contain complete nutrients but in small quantities and the process of absorption by plant roots is slower due to the process of further decomposition in the soil, so it takes longer to see growth results.

According to Liah et al. (2024), organic materials or organic fertilizers applied to the soil undergo a decomposition process first, the nutrients absorbed by the roots are relatively small, so that the existing nutrients are not sufficient to increase plant growth.

In accordance with the opinion of Musnawar (2003), organic fertilizer is the same as manure and green fertilizer, which is slow release, meaning that the nutrients in the fertilizer are released slowly and continuously over a certain period of time, so that the nutrients are not fully available to plants.

IV. CONCLUSION

The best nutrient content is organic fertilizer from cow shed waste with an organic C content of 31.17%, a C/N ratio of 17.42, a total N of 1.820%, a total P of 0.135, a total K of 0.256% and a pH of 7.78.

When compared to the standards of the Minister of Agriculture Regulation No. 261/KPTS/SR.310/M/4/2019, the organic fertilizers produced by the study were still below the standard, resulting in low nutrient quality.

The provision of organic fertilizer did not have a significant effect on the growth in height, number of leaves, length and width of leaves of pak choy plants.

SUGGESTION

Further research is needed regarding the addition of organic fertilizer raw materials to produce high nutrient content.

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